JCAB CARATS and ENRI's R&D Activities

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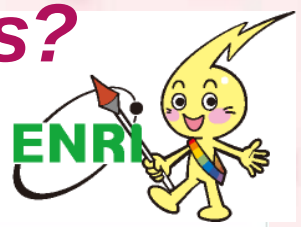
Background and Contents

- *JCAB published **the long-term vision for future air traffic systems (CARATS)** in 2010*
- ***CARATS road map** is now being made …*
- *ENRI also has a **long-term R&D vision***
- ***CARATS and ENRI research activities?***
- ***ENRI's contribution to CARATS?***



CARATS
Collaborative Actions for Renovation of Air Traffic Systems

1. **What is ENRI?**
2. **Overview of the JCAB long-term vision**
3. **ENRI's major R&D projects and results**
4. **CARATS and ENRI activities**

1. What is ENRI?

C. Hirasawa
President

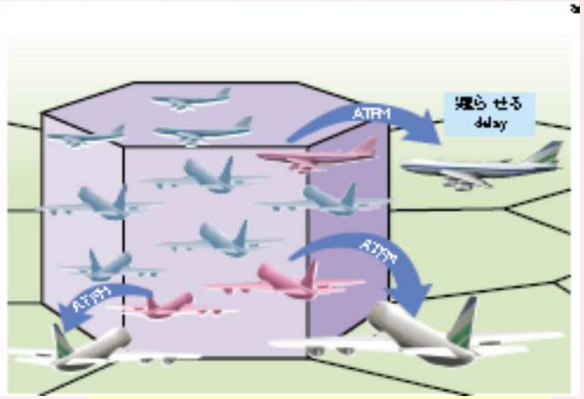
- ✓ ***E**lectronic **N**avigation **R**esearch **I**nstitute* (National Laboratory)
- ✓ Established in1967
- ✓ Funded mainly by **Ministry of Land, Infrastructure, Transport & Tourism**
- ✓ Budget: **¥1.6 billion** ~ 1,740 M$ (2012, including personnel cost)
- ✓ Personnel: **65** (47 researchers)

7-42-23 Jindaiji Higashi-machi, Chofu, Tokyo 1820012

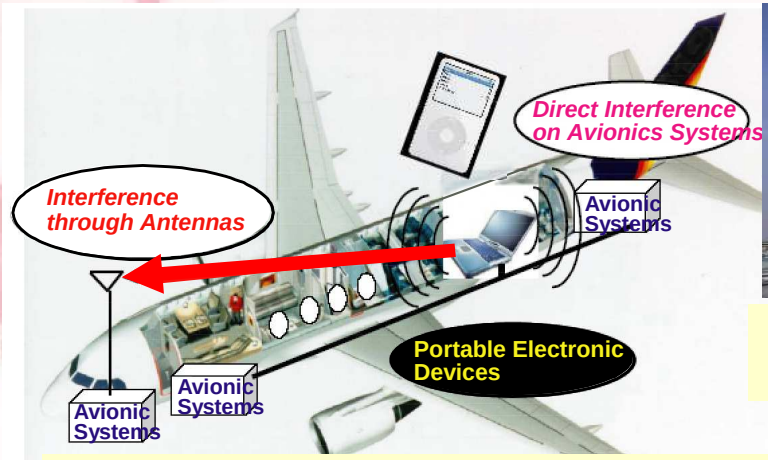
http://www.enri.go.jp/index.shtml

Major research areas

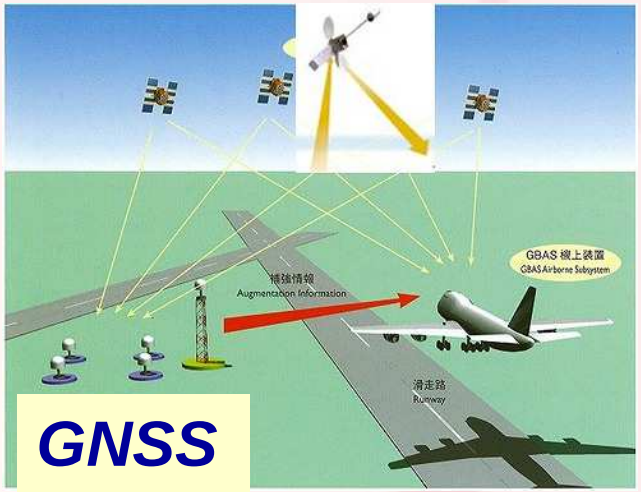
- **ATM** (Air Traffic Management)
- **Navigation systems** and operation
- **Surveillance, Communication** and Airborne systems



Separation & Flow Control



Surveillance

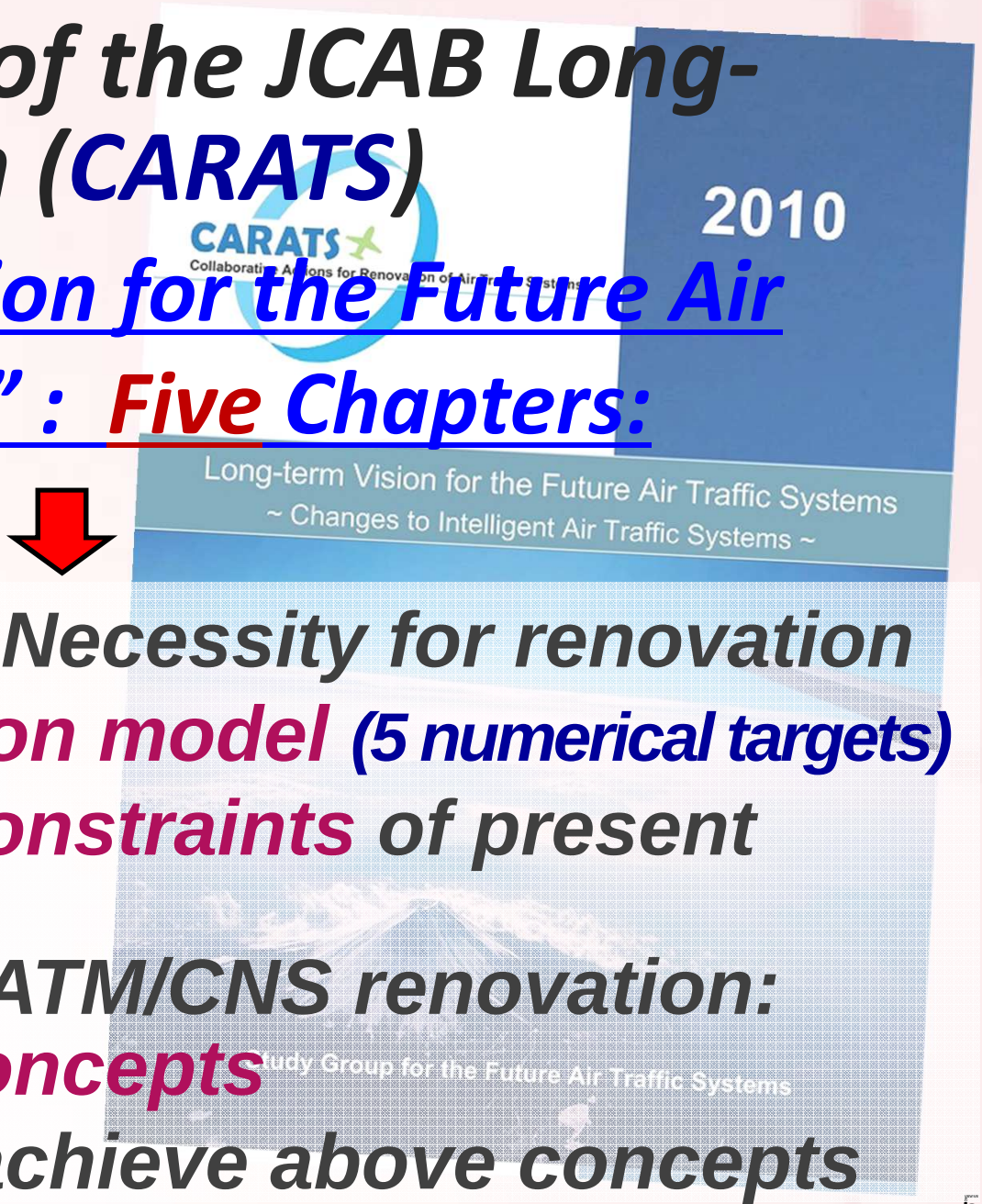


GNSS

Communication/Airborne Systems

2. Overview of the JCAB Long-term vision (CARATS)

"Long-term Vision for the Future Air Traffic Systems" : Five Chapters:



① **Background** & Necessity for renovation
② Future **operation model** **(5 numerical targets)**
③ Programs & **Constraints** of present Japanese air
④ **Processes** for ATM/CNS renovation: **eight (8) key concepts**
⑤ **Roadmaps** to achieve above concepts

◆ Eight Key Concepts …

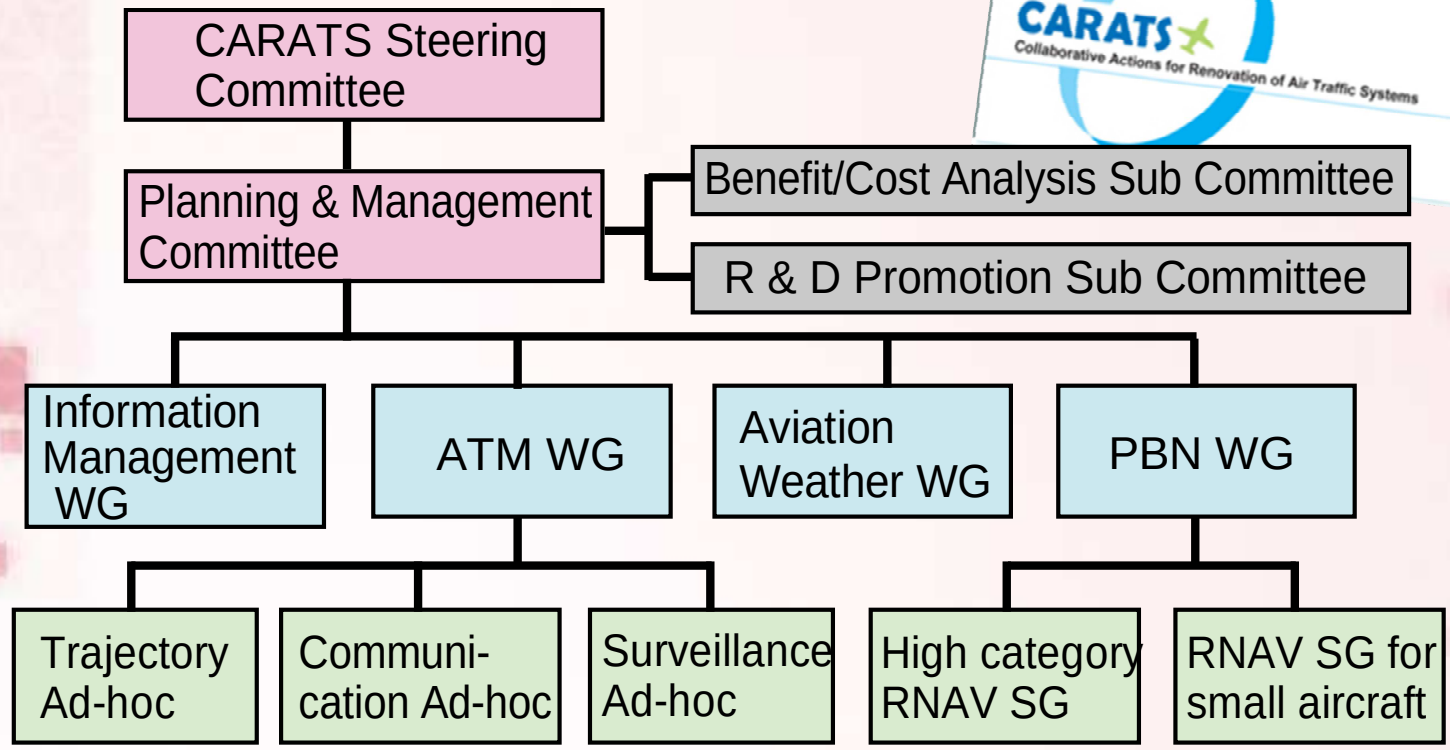
1. **Trajectory-Based Operation** (TBO)
2. **Predictability** Improvement
3. **Performance Based Operation** (PBO)
4. Total **Satellite-based navigation**
5. Enhanced **situation awareness**
6. Enhanced **human & machine capabilities**
7. **Information sharing** and CDM
8. **High density operation**

✓How to realize these concepts?

✓Collaboration among stake holders

◆ CARATS Organization

- *Task: development of road maps and practical implementation plan from the key concepts*



(CARATS organization in 2012)

Members: JCAB, Operators, Manufacturers, Laboratories and universities

◆ Measures from the key concepts

- **33 items for Operational Improvement (OI)**
- **13 items for Technical Improvement (EN)**

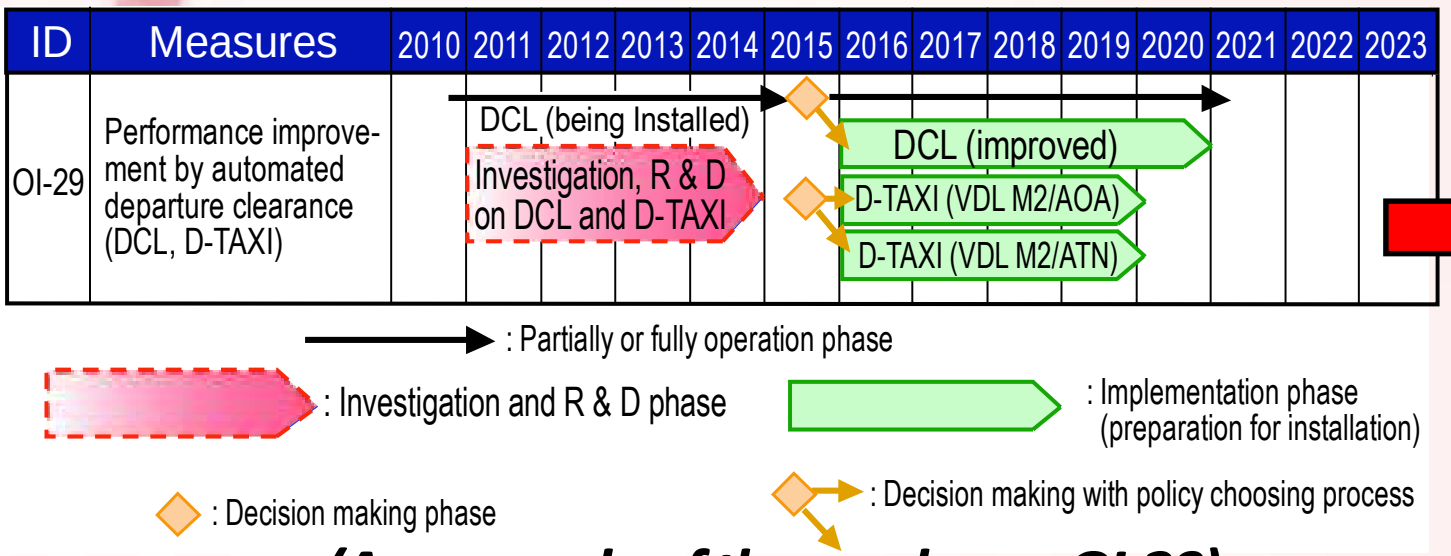
Phases	Subjects	ID	Measures
Airspace organi-zation	Flexible airspace management	OI-1	Operation in variable flight sector
		OI-2	Dynamic training area management
		OI-3	Dynamic terminal area operation
		OI-4	Area division in altitude direction
		OI-5	Free routing in very high altitude
		OI-6	Real time flight area reshaping
		OI-7	Flight area reorganization for TBO
		OI-8	Introduction of Flow Corridor
	Performance based navigation	OI-9	Precise and flexible departure, arrival and approach procedures
		OI-10	Precise RNP including time axis
		OI-11	Establishment of low altitude flight routes
		OI-12	Establishment of departure, arrival and approach procedures for small aircraft

(Examples of OI items)

◆ CARATS road map

●To fulfill each measure …

- ✓ Derive necessary procedures, technologies
- ✓ Prioritize each measure by procedural and technical maturity level, demands, costs etc
- ✓ Classify investigation, R&D, evaluation , decision making and implementation in yearly action basis



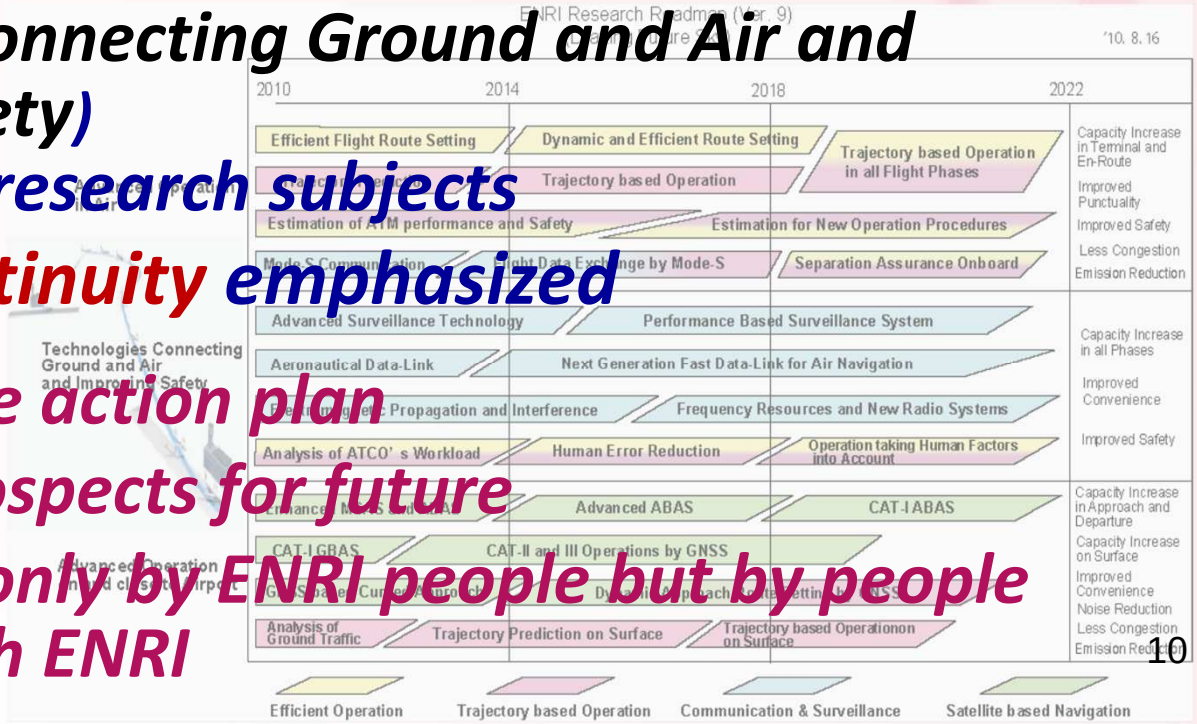
Guide for ATM/CNS system improve-ment

(An example of the road map OI-29)

3. ENRI's major R&D projects and results

◆ENRI long-term R&D vision

- ●Published in 2010 (Updated version)
- ●Three research domains (Advanced operation in Air, Advanced operation on and close to airport, Technologies connecting Ground and Air and improving safety)
- ●Twelve major research subjects
- ●Research continuity emphasized
  - ✓ ENRI's future action plan
  - ✓ Provides prospects for future
  - ✓ Shared not only by ENRI people but by people working with ENRI



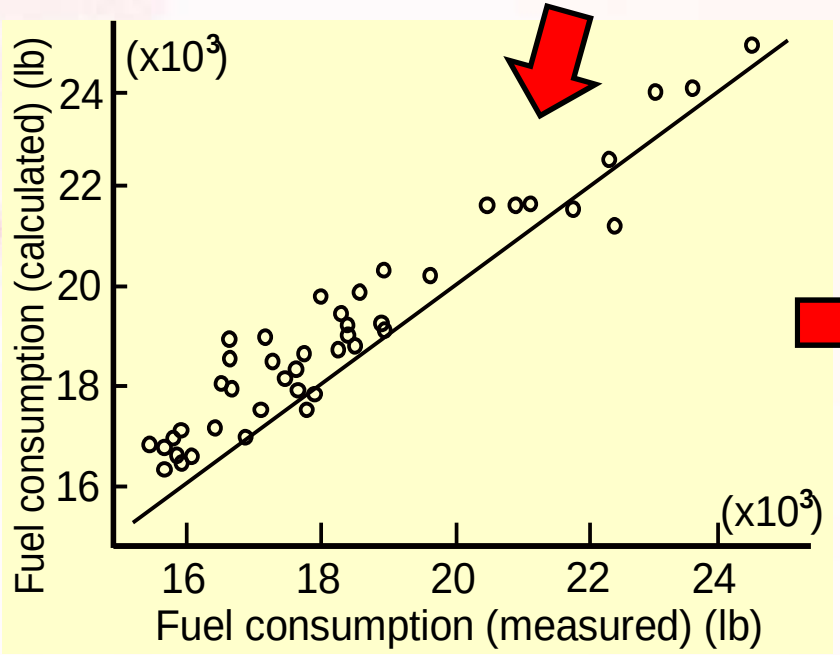
◆ Present ENRI major research topics

- **Project (11)**
- **Assigned**
- **Fundamental**
- **Investigation**
- **Contract**

ID	Project research topics
P-1	Construction of a trajectory model
P-2	Estimation of ATM Performance
P-3	Optimization of oceanic flight routes
P-4	Safety design and validation for CAT III GBAS
P-5	Study on fast aeronautical data link
P-6	An advanced surface surveillance system
P-7	Tolerability study for avionics against electromagnetic interference
P-8	Performance requirements for surveillance systems
P-9	Measurement of ATCO's workload
P-10	Development of hybrid surveillance technology
P-11	C-band surface communication link by WiMAX technology
ID	Typical other research topics
R-1	Collection and sharing of ionosphere data for extended GNSS application
R-2	Millimeter wave sensor network for foreign object detection
R-3	Precision curved approach and landing by GNSS operation
R-4	Analysis and simulation of airport surface traffic
R-5	Integrity augmentation for multiple GNSS
R-6	Numerical estimation of flight safety for future trajectory based operation
R-7	Development of a training assistance tool for
R-8	Integrity augumentation in multi-GNSS environment
R-9	Fabrication of an experimental UAS
R-10	En-route ATC simulation for CPDLC application
R-11	New information processing associated with SWIM

a) Estimation of ATM Performance (P-2)

- **ATM Performance?** ➡ **Air traffic quality, efficiency and safety ,**
- **Purpose** ➡ **Finding traffic bottlenecks and its mitigation procedures,**
- **Original fuel consumption model developed.**



✓ **Proportional!**

- **The research results are valid not only in Japan but in the world!**

Calculated and measured results agreed well!

d) GBAS prototype (P-4)

- **GBAS?** ➡ **Ground Based Augmentation System (GPS based landing system),**
- **Original CAT-I GBAS system with Ionosphere field monitor developed and tested.**

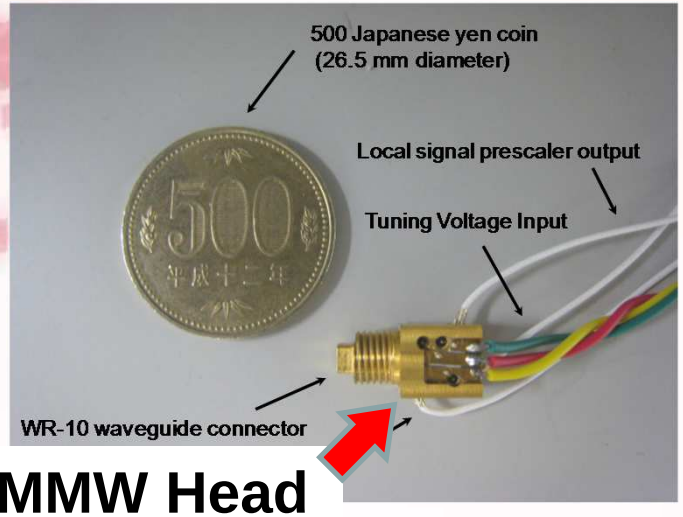
Boeing 787 at Osaka Kansai Airport

All function work perfect!

Validity of ENRI GBAS demonstrated by B787!

f) Millimeter wave technologies (R-4)

- ***Millimeter wave (MMW)?*** ➡ ***1 - 10mm wave-length radio*** ➡ ***future CNS applications,***
- ***Original MMW generator head developed,***
- ***Optically networked millimeter radar is under development for FOD.***



MMW Head

Runway debris detection

Validity of ENRI radar demonstrated!

4. CARATS and ENRI Activities

- **Major subjects discussed in CARATS in 2011-2012**
- **ENRI R&D topics corresponding to CARATS**

ID	Major subjects in measures	ENRI topics
EN-1	Improvement of radar data processing system for time based	
EN-2	Study on FF-ICE concept and its application	R-11
EN-4	Development of prototype Integrated Terminal Weather System	
EN-5	Introduction of high definition weather forecast database	
EN-9	Introduction of Wide Area Multilateration and its performance test	P-6, P-8
EN-11	Surveilance performance improvement for parallel runways	P-6, R-6
EN-12	Determination of flight parameters downlinked from aircraft	P-1, P-10
EN-13	Determination of meteorological data downlinked from aircraft	P-1, P-10
OI-9	Development of GBAS curved approach procedure	P-4, R-3
OI-11	Establishment of new RNAV routes for low altitude operations	P-2, R-2
OI-12	Coexistence of rotor and fixed wing crafts in departure and approach	R-6, R-8
OI-13	Data link performance for continuous ascent and descent operations	P-3, P-5
OI-18	Time based operation by initial CFDT	P-2
OI-19	Introduction of time-based metering at merging points	P-1, P-2
OI-21	Performance estimation of VDL-M2/AOA and ATN	R-10
OI-26	Safety estimation of separation reduction in wake turbulence	
OI-29	Near and mid future air and ground communication media	P-11, R-10
OI-31	Information enhancement on board – ground obstacles	P-11, R-2
OI-33	Accumulation, classification and validity test of Safety information	R-6

◆Short or near term CARATS targets and ENRI R&D

- **Most CARATS subjects are covered by ENRI R&D,**
- **Few exceptions as EN-1, OI-26 etc, which are treated by other institutes …**

◆ Examples of recent ENRI's commitments

- **EN-11: ENRI's Wide Area Multilateration (WAM) test data ➡ Advanced introduction of WAM for new parallel runway operation,**

- **OI-29: ENRI's information about VDLMode2**
  ➡ Delayed decision of CPDLC application in en-route operation.

ENRI's R&D is contributing to present CARATS!

◆ENRI Future researches and CARATS

Unmanned Aircraft Systems (UAS)

●Examples of ENRI's researches for future …

- ➢ Research on **UAS** (Unmanned Aircraft System)
  - Autonomous and controlled flights
  - Co-existence between unmanned and manned Aircrafts
- ➢ Research on **human factors**
  - Analysis and estimation of ATCO's workloads
  - Stress and drowsiness measurement technique
- ➢ Research on **Electromagnetic Compatibility (EMC)**
  - EMC enhancement and Frequency management
  - Electromagnetic interference tolerant avionics

◆ CARATS and ENRI's R&D …

-ENRI's R&D contributes not only to present CARATS but …. -

- Research on UAS will help develop future airspace management,
- Research on human factors will become the key to cope with future ATM paradigm shift,
- Research on EMC will open harmonized Electromagnetic environment for future CNS

Relationship between CARATS and ENRI R&D is widespread from current decision making to future policy establishment

5. Conclusions

- ***Introduction to ENRI***
- ***JCAB long-term vision***
  - + ***Eight key concepts for CNS/ATM renovation***
  - + ***CARATS road maps to realize the concepts***
- ***ENRI's major R&D topics and results***
  - + ***ENRI long-term R&D vision***
  - + ***Present ENRI major research topics and results***
- ***CARATS and ENRI activities***
  - + ***Near term subjects and future targets***

ENRI is fulfilling responsibility of contributing to CARATS in both near and long term basis

Thank you for your attention!

- People in ENRI -